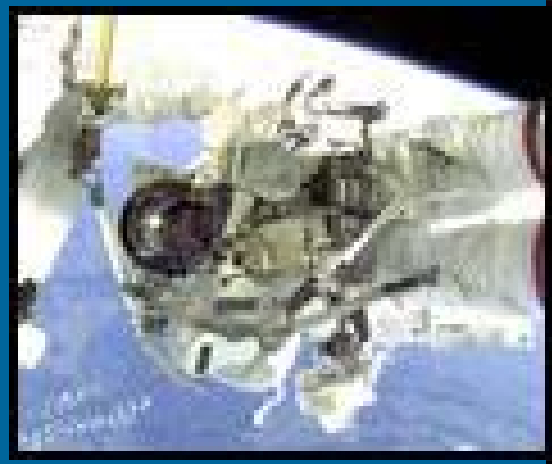
Managing a Wealth of Knowledge at NASA



Jeanne Holm
Jet Propulsion Laboratory
California Institute of Technology
April 11, 2001

What is Knowledge Management and Why Should We Care?

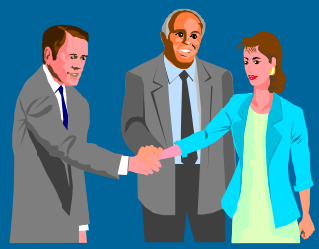
What is Knowledge Management at NASA?

- Knowledge management is getting the right information to the right people at the right time, and helping people create knowledge and share and *act upon information* in ways that will measurably improve the performance of NASA and its partners

How Have Organizations Changed?

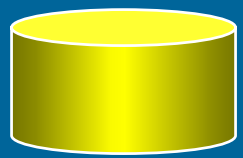
- Benchmarked organizations succeed at KM when they
  - Encourage and support communities of practice
  - Balance their long-term corporate needs (capturing knowledge) with short-term local needs (completing a task quickly)
  - But…the most critical factor in the success of a KM implementation is cultural acceptance
    - Acknowledging the appropriateness and acceptance of knowledge sharing and reuse (individual vs. organization)
    - Recognizing and rewarding people for sharing knowledge, such as
      - Capturing team discussions and decisions
      - Creating a supportive environment for mentoring
      - Documenting lessons learned
      - Making tacit knowledge explicit

KM's Goal is to Unite Knowledge Seekers with Knowledge Resources



Services
- Document Management
- Search
- Collaboration

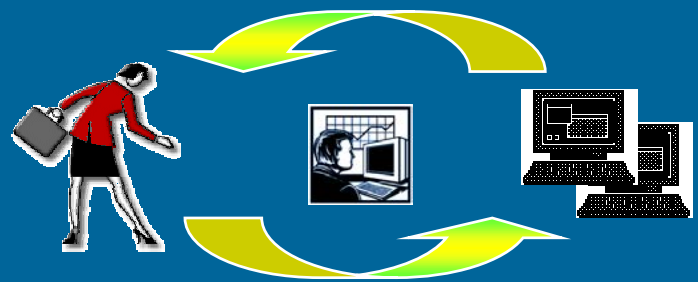
KM System
- Standards
- Protocols
- Metadata



Knowledge Worker *Knowledge Management* *Knowledge Resources*

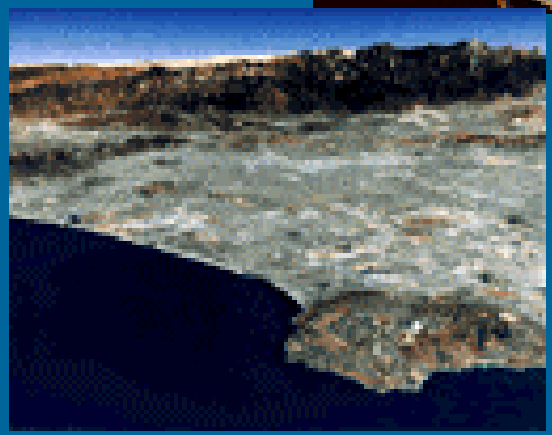
Creating a Knowledge Architecture

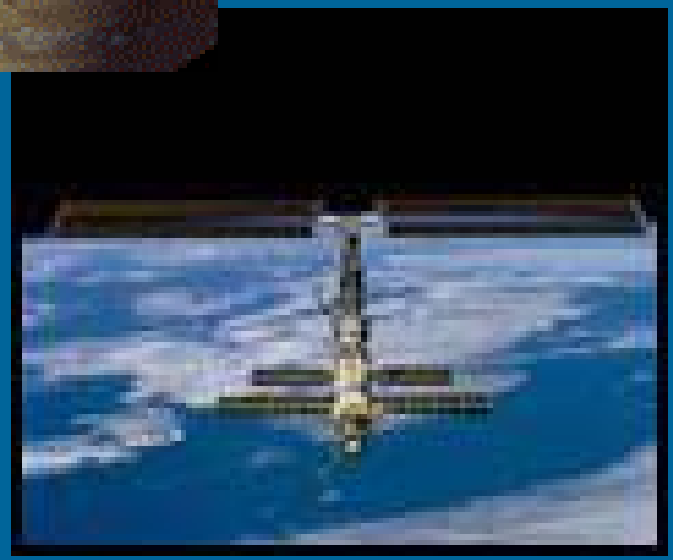
- There are three ways to look at architecting a KM program
  - **Process**: Oriented on the way in which people do their day-to-day work in the organization (the *how* and *why*)
  - **Services**: Focused on who will help people share their knowledge and who will maintain tools and processes (the *who*)
  - **Systems**: Are the IT infrastructure and tools necessary to deliver the processes and services efficiently and effectively to the end users (the *what* and *where*)



Services Processes Systems

Implementing a Knowledge Architecture at NASA





Why Is KM Critical to NASA?

- We are constantly challenged to document and integrate our lessons learned to effectively manage the risk involved in space exploration and human space flight
- By its nature, NASA employees have specialized, compartmentalized knowledge
- The workforce in the Agency is aging
- *Our goal is to share knowledge with each other and with the public*

Key Areas for NASA's KM Strategy

- To sustain NASA's knowledge across missions and generations
  - KM will identify and capture the information that exists across the Agency
- To help people find, organize, and share the knowledge we already have
  - KM will efficiently manage NASA's knowledge resources
- To increase collaboration and to facilitate knowledge creation and sharing
  - KM will develop techniques and tools to enable teams and communities to collaborate across the barriers of time and space

Framework for KM at NASA

Sharing and Using Knowledge

People	Process	Technology
• Enable remote collaboration • Support communities of practice • Reward and recognize knowledge sharing • Encourage storytelling	• Enhance knowledge capture • Manage information	• Enhance system integration and data mining • Utilize intelligent agents • Exploit expert systems

Supporting Activities

Education and Training	IT Infrastructure	Human Resources	Security

Implementing a Knowledge Architecture for NASA

- NASA's KM activities are led by the Chief Information Officer (Lee Holcomb) and guided by the NASA KM Team
  - The team members represent the diversity of NASA customers and organizations, from anthropologists to IT architects
- The team works with a wide variety of activities to help infuse KM goals and solutions into the day-to-day work of the Agency
  - Just as knowledge is distributed amongst all our employees and partners…KM delivers solutions to the area where they area needed, rather than building a centralized knowledge warehouse

KM Partnerships

- Lots of people are already doing KM, our job is to find *good* solutions and build a federation of resources for our employees and partners
- KM supports other processes and initiatives, building infrastructure, applications, and “filling the gaps” for processes, tools, and methods
  - Think of KM as an “enabler”
  - KM’s goal is to help infuse new ideas or needed technology and to leave or turn over operations to the appropriate content area
- We actively share and benchmark with other Agencies, the National lab community, and academia

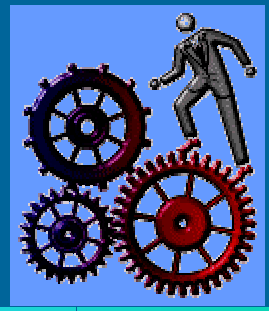
What Have We Been Working On?

- Knowledge Navigation: Getting people access to the information we have
  - Employing an enterprise information portal to allow customized views into NASA internal and external resources
    - Stimulate development of interoperable standards, architectures, and knowledge transfer processes between Centers
    - Facilitate and broadcast communities of practice
    - Consolidate current, multiple publishing venues
    - to take NASA into the next generation of web usage
    - Integrating products for the user interface from iPlanet (Sun, Netscape, AOL) and agents and communities from Autonomy
    - Currently in beta roll out at one Center

NASA Portal in Development

http://km.jpl.nasa.gov/portal/insidenasa

Capturing Lessons Learned



- Lessons Learned Information System Redesign
  - Create and maintain a knowledge resource to facilitate archival, access, and incorporation of NASA safety and engineering experiences
    - Focuses on improving ease of capture and re-use, extending data types to include all information associate with a lesson
    - Integrating information from lessons into risk management tools, processes, procedures, and standards
  - Increase the “design for safety” by building into our processes the lessons learned by others and mitigate risk through better integration of Agency knowledge
  - Deliver information to NASA team members *at the time they need it* to make a better decision for the mission and the Agency

Locating Experts at NASA

- Experts Directory Service
  - Quickly find science and engineering experts across the Agency for NASA personnel trying to locate others working in a related field or on a particular project to facilitate collaboration among distributed groups
    - Working with Florida International University and University of Maryland, Baltimore County to prototype profiling, agent technology, and searching
    - Established connectivity to Human Resources and other “experts-related” databases
    - Using Autonomy software product suite

Where Are We Heading?

- In the next year, KM will be working on solving our three priorities:
  - Knowledge capture
  - Information management
  - Collaboration for communities of practice

Capturing More Knowledge

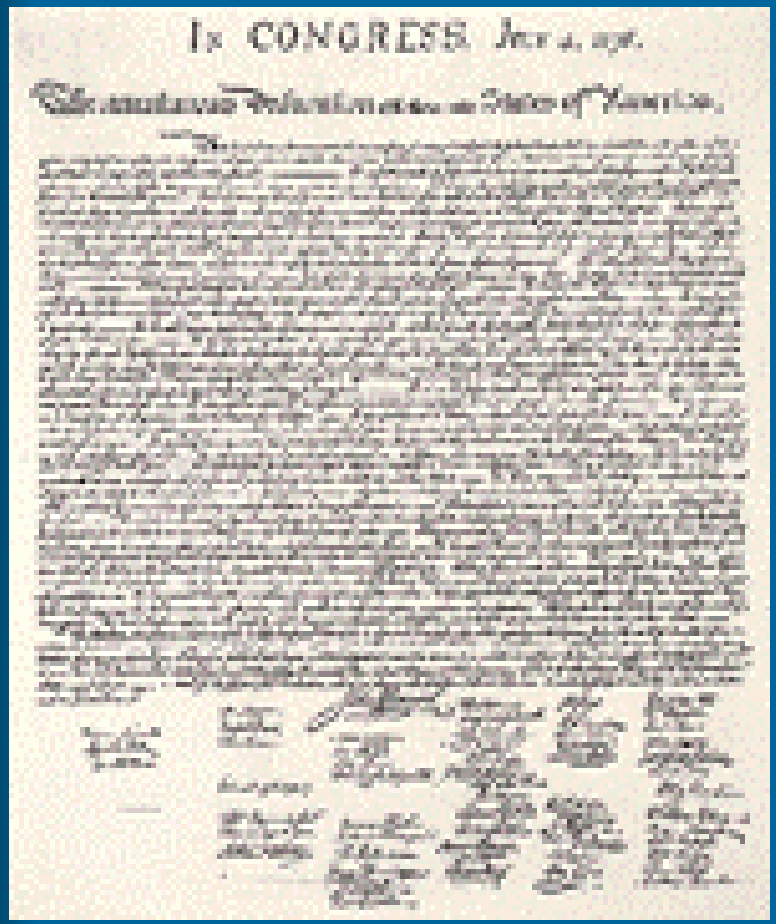
- Focus 1: Capturing more tacit knowledge from projects and experts
- The questions we ask will help to lead us to solutions that can be implemented for projects across the Agency
  - How are decisions reached at critical points in a mission and how is the information captured?
  - How can we share that across missions and generations?
  - How do we address our aging workforce?
  - How do we handle our highly compartmentalized knowledge?
- Sample solution: The Technical Questions Database provides key questions that could be asked during a review, with the purpose of identifying and preventing problems from occurring on flight projects

Technical Questions Database

Managing Information

- Focus 2: Managing our explicit information more efficiently
  - What is the lifecycle needed to manage information and support a rich authoring environment (tools, templates, guidelines)?
  - Our electronic libraries are highly distributed—how do we effectively manage and distribute that information?
    - Work on interoperability, rather than integration
    - Mostly using COTS solutions customized to NASA's requirements
- Sample solution: Advocate the use of consistent metadata (such as the Dublin Core), naming conventions, and schemas across the repositories
  - More at http://step.jpl.nasa.gov

Use of Standards for Interoperability



TITLE: The Declaration of Independence
CREATOR-1: Thomas Jefferson
PUBLISHER: The Second Continental Congress
CONTRIBUTOR-1: Benjamin Franklin
CONTRIBUTOR-2: John Adams
CONTRIBUTOR-3: Roger Sherman
CONTRIBUTOR-4: Robert R. Livingston
SUBJECT: freedom, political ties, inalienable rights, life, liberty, pursuit of happiness
DESCRIPTION: A political treatise outlining grievances against King of Great Britain [George III] and the the declared rights of the American colonies and its citizens
DATE.COMPLETED 1776-07-04
DATE.SIGNED: 1776-08-02
TYPE: Political treatise
FORMAT: Hardcopy - parchment
SOURCE: National Archives, Washington, DC
LANGUAGE: en
COVERAGE: The United States of America
RIGHTS: Unlimited Distribution }

Supporting Communities of Practice

- Focus 3: Enabling remote collaboration to support virtual teams and communities of practice
  - What do virtual teams need as an infrastructure in order to efficiently do their work?
  - How can we capture the “mobile” knowledge of a virtual team?
  - What services do virtual teams need in order to work effectively?
- Sample solution: Team start up kits
  - A welcome kit of collaborative tools and techniques, integrating new and pre-existing services
    - Process for team and project start up
    - Integrated and engineered suite of collaborative tools
    - Integration with operational service bases

Team Start Up Kits

- Integrate standard capabilities needed for each team, including
  - Videoconferencing
  - Asynchronous discussions
  - Tele- and dataconferencing at the desktop
  - Shared work spaces for sharing information
  - Calendaring
  - Instant messaging

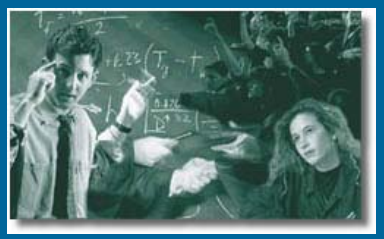
Checklist for Successful Implementation

- In looking at best internal practices, KM choices should judge success by ensuring
  - High accessibility, searchability, and ease of use
  - Potential to save a large amount of work
  - Potential to help avoid expensive problems
  - Richness of the data repository
  - Features such as online help, help desk, and frequently asked questions
  - Openness to unsolicited submissions of information

Guiding Rule: Tie KM Solutions to Business Drivers

- Whenever you are selecting a KM solution to implement, tie it to the core issues and business drivers for that company
- KM solutions are not “one-size-fits-all” and need to be tailored for each organization
- NASA was no exception
  - As an example, JPL’s 25-year KM strategy is linked to those technologies and infrastructure services that will be needed by missions planned over the next decades

JPL Knowledge Management Roadmap



Sharing Knowledge

- Adaptive knowledge infrastructure is in place
- Knowledge resources identified and shared appropriately
- Timely knowledge gets to the right person to make decisions
- Intelligent tools for authoring through archiving
- Cohesive knowledge development between JPL, its partners, and customers

Enables sharing of essential knowledge to complete Agency tasks

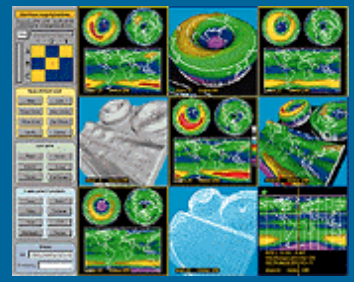
- MarsNet
- Europa Orbiter
- SIM

Integrating Distributed Knowledge

- Instrument design is semi-automatic based on knowledge repositories
- Mission software auto-instantiates based on unique mission parameters
- KM principals are part of Lab culture and supported by layered COTS products
- Remote data management allows spacecraft to self-command

Enables seamless integration of systems throughout the world and with robotic spacecraft

- Europa Lander/Submersible
- Titan Organics: Lander/Aerobot
- Neptune Orbiter/Triton Observer

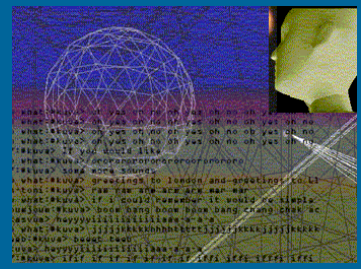


Capturing Knowledge

- Knowledge gathered anyplace from hand-held devices using standard formats on interplanetary Internet
- Expert systems on spacecraft analyze and upload data
- Autonomous agents operate across existing sensor and telemetry products
- Industry and academia supply spacecraft parts based on collaborative designs derived from JPL's knowledge system

Enables capture of knowledge at the point of origin, human or robotic, without invasive technology

- Mars robotic outposts
- Comet Nucleus Sample Return
- Saturn Ring Observer
- TPF



Modeling Expert Knowledge

- Systems model experts' patterns and behaviors to gather knowledge implicitly
- Seamless knowledge exchange with robotic explorers
- Planetary explorers contribute to their successor's design from experience and synthesis
- Knowledge systems collaborate with experts for new research

Enables real-time capture of tacit knowledge from experts on Earth and in permanent outposts

- Interstellar missions
- Permanent colonies

2003 2007 2010 2025

So What Have We Done Right and Wrong?

How Do You Actually Do KM?

- For KM to move from ideas to implementation, the definition of KM needs to address
  - Creating, sharing, and reusing knowledge
  - Understanding the relevance of different information as determined by the *customer*
  - Training for KM methods and services
  - Incorporating cultural aspects of KM into operations
  - Responding to funding and chargeback issues

Lessons Learned in Our Journey

- Cultural and political issues will take the most time, so plan for it!
- Get executive sponsorship
- Find others doing or supporting “knowledge management”
  - Enlist, encourage, empower (baptize the evangelists)
  - Build a federated team with diverse talents
  - Recruit the best people and prepare for them to leave
- Design a long-term, sustainable solution
  - Repeatedly gather requirements
  - Provide rigorous system engineering

Lessons Learned (continued)

- Develop solutions, services, and rewards
  - Deliver specific solutions to specific customers
  - Build KM into the way people already do their jobs
  - Make services are operational (including funding and metrics)
  - Reward knowledge sharers through promotions, recognition, and time to learn and share
  - Recognize and celebrate contributions of the KM team and others
- Keep the alliances strong
- Don't try to solve the whole problem—just start somewhere and solve part of the problem

Thanks!

- Many thanks to my NASA colleagues who contributed to these ideas and to the excellent work they are doing in implementing knowledge management solutions at NASA
- If you have any additional questions about the work of NASA or JPL in the area of knowledge management, please contact me:

Jeanne Holm
Jet Propulsion Laboratory
4800 Oak Grove Drive, Mail Stop 202-204
Pasadena, CA 91109
Jeanne.Holm@jpl.nasa.gov
(818) 354-8282
http://www.jpl.nasa.gov
http://www.nasa.gov